

U.S Integrated Earth Observation System

National Integrated Drought Information System

Preamble

The USGEO is coordinating the activities to formulate integration framework documents for the six near-term opportunity areas identified in the Strategic Plan for the U.S. Integrated Earth Observation System.

One of the steps is to take inventory of the Earth observation systems, models, and decision support systems that exist or are planned to be developed over the coming years. The following tables are initial compilations of U.S. capabilities in Earth observation systems, models and decision support systems. Earth observation systems, models, and decision support systems identified in the tables are candidates for inclusion in Integrated Earth Observation System configurations for each of the near term opportunity areas.

These tables are draft and as such, are neither exclusive nor comprehensive. We invite interested members of the community to provide input to the content of these tables and system configurations – both during the sessions on the second day of the IEOS Public Engagement Workshop and through email submissions to the USGEO. Your review and input to these tables and to the Integrated Earth Observation System configurations for each of the near term opportunities is greatly valued and appreciated.

Draft Table 1. Products, Services, Observing Systems and Models

| Products/Services | Observing System/Model | Instrument/Parameter | Agency |
|-------------------------------------|---|--|--------------|
| Snow water equivalent & snow depth | SNOwpack TELelemetry | High elevation snow depth and SWE | USDA-Surface |
| Soil moisture and crop conditions | NASS network of local observers | State & crop-reporting-district conditions | |
| Surface meteorological observations | RAWS - Remote Automated Weather Stations | Temp, Solar Radiation, Humidity, Winds, Precip, Soil Conditions, Fuel Moisture | |
| Surface meteorological observations | SCAN - Soil Climate Analysis Network | Temp, Solar Radiation, Humidity, Winds, Precip, Soil Conditions | |
| Surface meteorological | GrazingLands Research Laboratory Micronet - | Temp, humidity, precipitation, solar | |

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| Products/Services | Observing System/Model | Instrument/Parameter | Agency |
|---|------------------------------------|---|----------------|
| observations - 42 station network | Little Washita River Watershed | radiation, soil temperature | |
| Soil conditions for fire potential assessment | Wildland Fire Assessment System | Keetch and Byram Drought Index | USDA-Model |
| Fire potential | Wildland Fire Assessment System | Other Indices | |
| Precipitation | NWS-COOP | 8-inch, Heated Tipping, Fisher Porter, Belfort Rain Gauge, Geonor | NOAA - Surface |
| | NWS-NERON | | |
| | NWS-ASOS | | |
| | NESDIS-CRN | | |
| | NWS-LARC | | |
| | OAR-FRD Mesonet | | |
| Surface air Temperature | NWS-COOP | MMTS, Platinum Resistance Thermometer, Thermistor | |
| | NWS-NERON | | |
| | NWS-ASOS | | |
| | NESDIS-CRN | | |
| | NOS-PORTS | | |
| | NWS-VOS | | |
| | OAR-FRD Mesonet | | |
| Sea surface temperature | NWS-VOS | Thermistor | |
| | OAR-ENSO-Drifting Buoys | | |
| | OAR-TAO-TRITON | | |
| | NOS-PORTS | | |
| Ocean surface winds | OAR-ENSO-Drifting Buoys | Wind Spd/Dir | |
| | OAR-TAO-PIRATA | | |
| | OAR-TAO-TRITON | | |
| Ocean temperature profile | OAR-ARGO | Profiling Floats | |
| Water conductivity | NOS-PORTS | WC Sensor | |
| Sea Level Pressure | NWS-VOS (Volunteer Observing Ship) | Barometer | |
| Land surface wind speed | NESDIS-CRN | Anemometer | |
| | NWS-NERON | | |
| | NWS-ASOS | | |
| | NOS-PORTS | | |
| | OAR-ARL-SURFRAD | | |
| | OAR-FRD Mesonet | | |
| Land surface wind direction | NWS-NERON | Anemometer | |
| | NWS-ASOS | | |
| | NOS-PORTS | | |
| | OAR-ARL-SURFRAD | | |
| | OAR-FRD Mesonet | | |
| Ground surface (skin) temperature | NESDIS-CRN | IR Sensor | |
| Humidity | NESDIS-CRN | Vaisala Capacitance | |
| | NWS-ASOS | | |
| Radar-derived precipitation totals | NWS-NEXRAD Radar Reflectivity | Radar Reflectivity | |
| Radar-derived wind | NWS-NEXRAD Radial | Radial Velocity | |

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| Products/Services | Observing System/Model | Instrument/Parameter | Agency |
|---|---|--|-----------------|
| Direction | Velocity | | |
| River stage, stage height | NWS-LARC (Limited Automated Remote Collector) Stage Height | Stage Height | |
| Evaporation | NWS-COOP | Pans | |
| Soil moisture | NWS-NOHRSC | Pulse Height Analyzer | |
| Snow water equivalent | NWS-NOHRSC | Scintillation Detector | |
| Palmer Drought Indices, Crop Moisture Index, Z-Index | Palmer Model | Drought Severity Measure | NOAA-Model |
| Standardized Precipitation Index | SPI Model | Drought Severity Measure | |
| Evaporation, soil moisture | CPC One-Layer Hydrological Model (Leaky) | Soil Conditions | |
| Streamflow, lake and reservoir level, snowpack, soil moisture, and water supply forecasts | NWS River Forecast System | Calibration and Operational Forecast System | |
| Real-time rainfall estimates | Multisensor Precipitation Estimator | Radar, gauge and satellite-derived precipitation | |
| Seasonal forecasts | Climate Forecast System Model (CFS) OCN, CCA, MLR | | |
| 6-10, 8-14 Day Forecasts | Global Forecast System Model (GFS) | | |
| Short-term forecasts | North American Mesoscale Model (NAM), Rapid Update Cycle Surface Assimilation System (RSAS) | | |
| Atmospheric data assimilation | Global: CDAS, GDAS/GFS Regional: NARR/Eta-Noah | 3-D atmospheric fields | |
| Ocean data assimilation | GODAS/MOM3/XBTs, TAO, Argo | Marine fields | |
| Precipitation analysis | CMAP/GPI,OPI,SSM/I, MSU/GFS CMORPH/AMSU-B, SSM/I, TMI, AMSR/E | Merged analysis precipitation data | |
| Land data assimilation | LDAS/Noah, VIC, Mosaic, Sacramento/GOES, Doppler radar, gage | Soil, snow, surface characteristics | NOAA/NASA-Model |
| Snow data assimilation | NSA/SNODAS | 1km gridded snow and precipitation data from satellite/air/ground observations | |

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| Products/Services | Observing System/Model | Instrument/Parameter | Agency |
|---|---|--|-----------------|
| Normalized Diff Veg Health Index | POES/NPOESS (National Polar-Orbiting Operational Environmental Satellite System) | AVHRR | NOAA-Spaceborne |
| Cloud mask | | | |
| Snow cover | | | |
| Global land cover characterization | | | |
| Atmospheric temp | | AMSU | |
| Precipitation | | | |
| Sea sfc winds | | Conical Microwave Imager/Sounder | |
| Soil moisture | | | |
| Precipitable water | | | |
| Snow cover / snow depth | | | |
| Surface wind stress | | | |
| Operational Clear-Sky VIS Composite | | GOES 8-12 | |
| Operational Surface Albedo | | | |
| Operational Surface Insolation | | | |
| Water vapor transport | | | |
| Operational skin temperature Operational total precipitable water Atmospheric temperature | GOES 8-12 | GOES Sounder | |
| Surface Water Supply Index | SWSI Model | Hydrologic conditions based on reservoir level snow cover, streamflow, precipitation | USGS-Surface |
| Snowpack conditions | Snowcourse sites | Mountain snowcourse | |
| Streamflow percentiles | Hydro-Climatic Data Network (NCDN), National Streamflow Info. Pgm (NSIP), Nat. Water Info. System | | |
| Well levels | | Groundwater Monitoring Wells | |
| Landscape characterization | GMAO Ocean | North American Char. | USGS-Model |
| Landcover data | GSFC GOCART | National Landcover | |
| National land cover data | Landsat 5/7 | Thematic Mapper/Enhanced TM | USGS-Spaceborne |
| Surface meteorological observations for agriculture | Bureau of Reclamation AgriMet Stations | Temp, Solar Radiation, Humidity, Winds, Precipitation, Soil Temp/Moisture, Pan Evaporation | DOI-Surface |
| Water resource | Bureau of Reclamation | Temperature, | |

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| Products/Services | Observing System/Model | Instrument/Parameter | Agency |
|--|---|---|----------------------------|
| systems | Hydromet Stations | Precipitation, Snow Water Equivalent, Gage height, discharge | |
| | | | NASA-Surface |
| Rainfall rate | GMAO Ocean | | NASA-Model |
| Surface fluxes | | | |
| Vegetation indices | GSFC GOCART | | |
| Evapotranspiration | | | |
| Rainfall rate | | | |
| Humidity product | LANL POP Ocean | | |
| Total precipitable water | | | |
| Rainfall rate & profile | ER-2 | EDOP-ER-2 Doppler Radar | NASA-Airborne |
| | | AMPR-Advanced Microwave Precipitation Radiometer LIP-Lightning Instrument Package HAMSR-High Alt. MMIC Sounding Radiometer. | |
| Land cover classification, total precipitation. water, snow cover, vegetation indices, evapotranspiration. | Terra | MODIS - Moderate Resolution. Imaging Spectroradiometer | NASA-Spaceborne |
| Surface fluxes, clouds | | CERES - Clouds & Earth's Radiant Energy System | |
| Humidity product | Aqua | AIRS - Atmospheric Infrared Sounder | |
| Rainfall rate & profile | TRMM | Precipitation Radar | |
| | | Lightning Imaging Sensor | |
| | | TRMM Microwave Imager | |
| | Aqua | AMSR-E-Advanced Microwave Scanning Radiometer for EOS | |
| Radiometric observations | Atmospheric Radiation Measurement Program (ARM) - Radar, Lidar, Radiometers | Irradiance, longwave, shortwave radiation, etc. | DOE-Surface and Airborne?? |
| Cloud properties | ARM - Lidar, Ceilometers, Sky Imagers, Cloud radars, | Aerosol scattering, cloud boundaries, reflectivity, water vapor, liquid water path etc. | |
| Surface meteorological observations | SMOS-Surface Meteorological Observing System | Temperature, humidity, precipitation, winds, pressure | |

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| Products/Services | Observing System/Model | Instrument/Parameter | Agency |
|--|---|--|----------------|
| Surface energy fluxes | ECOR-Eddy Correlation Systems/PGS-Precision CO2 Mixing Ratio System/EBBR-Energy Balance Bowen Ratio | Latent, Sensible heat flux, soil heat flux, soil moisture etc. | |
| Rainfall rate & profile | DMSP F-13, F-14, F-15 | SSM/I-Special Sensor Microwave Imager | DoD-Spaceborne |
| | DMSP F-16, F-17 | SSMIS-Special Sensor Imager Sounder | |
| | | | EPA-Surface |
| | | | EPA-Models |
| 1-meter b&w, 4-meter multispectral, 1-meter color, and 1 and 4-meter data bundle | IKONOS | 11 bit panchromatic-11 bit multispectral | Space Imaging |
| 1-meter b&w, 4-meter multispectral, 1-meter color, and 1 and 4-meter data bundle | QuickBird | Panchromatic-Multispectral | Digital Globe |

Draft Table 2. Decision Support Systems

| Decision Support Tool | Description | Contributing Agencies |
|--|--|---|
| BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) ¹ | Facilitate examination of environmental information | EPA, USDA, USGS, BoR |
| | Provide an integrated watershed and modeling framework | |
| | Support analysis of point and nonpoint source management alternatives | |
| | Evaluate urban/rural land use | |
| AWARDS (Agricultural Water Resources Decision Support) ² | Estimate water consumption by crops | EPA, USDA, USGS, BoR |
| | Assess crop suitability | |
| | Determine irrigation requirements | |
| RiverWARE ³ | Estimate river flow and water loss to vegetation | EPA, USDA, USGS, BoR |
| | Assess river sustainability | |
| U.S. Drought Monitor ⁴ | Web-based product relies on multiple indicators and climate indices and has greatly increased public awareness of drought in the United States. This product is currently being used to track drought status and severity, and is used for key | NOAA, USDA, National Drought Mitigation Center (NDMC) |

¹ Earth Science 2004 Applications Plan, p. 22.

² Ibid, p.22.

³ Ibid, p. 22.

⁴ Ibid, p.22.

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| Decision Support Tool | Description | Contributing Agencies |
|--|--|-------------------------------|
| | policy decisions on eligibility for disaster assistance programs. ⁵ | |
| U.S. Water Supply Forecasts | Electronically distributed product, providing seasonal water resource forecasts on both a broad and local scale | NOAA, NRCS |
| U.S. Seasonal Drought Outlook ⁶ | Depicts general, large-scale trends based on subjectively derived probabilities and guided by numerous indicators, including short- or long-range statistical and dynamical forecasts. | NOAA |
| North American Drought Monitor | Web-based product that depicts drought conditions across the U.S., Canada, and Mexico in coordination with the U.S. Drought Monitor (USDM). This product is prepared jointly by the USDM agencies in the U.S., the National Meteorological Service of Mexico (SMN), and Environment Canada and Agriculture Agrifood Canada to track drought status and severity across international boundaries. It is used as a tool in international water management decisions. | NOAA, USDA, NDMC |
| Applied Climate Information System (ACIS) ⁷ | Internet-based system designed to provide directed access for user specified queries to climate data archives. The availability of products on ACIS allows the user to conduct their own climate analyses using high quality data. ACIS is a distributed and synchronized system that provides consistent and timely climatic products. | NOAA Regional Climate Centers |

⁵ <http://www.unisdr.org/wcdr/thematic-sessions/thematic-reports/report-session-2-2.pdf>

⁶“Creating a Drought Early Warning System for the 21st Century,” Western Governors’ Association, June 2004. <http://www.westgov.org/wga/publicat/nidis.pdf>

⁷ <http://www.rcc-acis.org>

Acronym List

A

| | |
|--------|--|
| ACCA | Automatic Cloud Cover Assessment |
| ADEOS | Advanced Earth Observation Satellite |
| AGS | Alaska Ground Station |
| AIRMoN | Atmospheric Integrated Research and Monitoring Network |
| ALOS | Advanced Land Observing Satellite |
| AMSR | Advanced Microwave Scanning Radiometer (satellite) |
| AMSU | Advanced Microwave Sounding Unit (satellite) |
| ANSS | Advanced National Seismic System |
| AQI | Air Quality Index |
| ASAR | Advanced Synthetic Aperture Radar (on Envisat) |
| ASTER | Advanced Spaceborne Thermal Emission and Reflection Radiometer |
| ATBD | Algorithm Theoretical Basis Document |
| AU | Astronomical Unit |
| AVHRR | Advanced Very High Resolution Radiometer |
| AVIRIS | Airborne Visible-Infrared Imaging Spectrometer |

B

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|------|---|
| BRDF | Bidirectional Reflectance Distribution Function |
|------|---|

C

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|--------|---|
| CCD | Charge Coupled Device |
| CCSDS | Consultative Committee for Space Data Systems |
| CCSP | Climate Change Science Plan |
| CENR | Committee on Environment and Natural Resources |
| CEOS | Committee on Earth Observation Satellites |
| CMAQ | Community Multi-scale Air Quality model |
| COSPEC | Correlation Spectrometer (to detect SO ₂) |
| CPF | Calibration Parameter File |
| CRAM | Combined Radiometric Correction Model |

D

| | |
|------|--|
| DART | Deep-ocean Assessment and Reporting of Tsunami |
| DEM | Digital Elevation Model |
| DFCB | Data Format Control Book |
| DHS | Department of Homeland Security |
| DIS | Data and Information System' |
| DMSP | Defense Meteorological Satellite Program |
| DoD | Department of Defense |
| DOE | Department of Energy |
| DOI | Department of the Interior |
| DOQ | Digital Orthophoto Quadrangle |
| DOT | Department of Transportation |
| DRM | Data Reference Model |

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E

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|--------|--|
| ECS | EOSDIS Core System |
| ECV | Essential Climate Variables |
| EDM | Electronic Distance Measurement |
| EOS | Earth Observing System; Earth Observing Subcommittee |
| EOSAT | Earth Observation Satellite Company |
| EOSDIS | EOS Data and Information System |
| EPA | Environmental Protection Agency |
| EPGS | EOS Polar Ground Sites |
| EROS | Earth Resources Observation and Science |
| ERS | European Remote Sensing |
| ESA | European Space Agency |
| ET | Evapotranspiration |
| ETM | Enhanced Thematic Mapper (Landsat instrument) |
| ETM+ | Enhanced Thematic Mapper Plus (Landsat instrument) |
| EVI | Enhanced Vegetation Index |

F

| | |
|------|---|
| FAC | Full Aperture Calibrator |
| FDF | Flight Dynamics Facility |
| FEAF | Federal Enterprise Architecture Framework |
| FGDC | Federal Geographic Data Committee |
| FOV | Field of View |
| FPAR | Fraction of Photosynthetically Active Radiation |
| FTP | File Transfer Protocol |

G

| | |
|---------|---|
| GAW | Global Atmospheric Watch |
| GCM | General Circulation Model |
| GCOS | Global Climate Observing System |
| GEOSS | Global Earth Observation System of Systems |
| GEOSAT | Geodetic Satellite |
| GeoTIFF | Geographic Tagged Image File Format |
| GLOS | Global Land Observation System |
| GOES | Geostationary Operational Environmental Satellite |
| GOOS | Global Ocean Observing System |
| GPS | Global Positioning System |
| GSD | Ground Sample Distance |
| GSN | GCOS Surface Network |
| GTOS | Global Terrestrial Observing System |
| GUAN | GCOS Upper Air Network |

H

| | |
|-------|---|
| HAZUS | Hazards U.S. (FEMA's Hazard and Risk Assessment software package) |
| HHS | Health and Human Services |

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I

| | |
|-------|---|
| IAS | Image Assessment System |
| IEOS | Integrated Earth Observation System |
| IFOV | Instantaneous Field of View |
| IGBP | International Geosphere-Biosphere Programme |
| IGCO | Integrated Global Carbon Observation |
| IGOS | Integrated Global Observation System |
| IGS | International Ground Stations |
| InSAR | Interferometric Synthetic Aperture Radar |
| IOC | Initial On-orbit Checkout |
| IPCC | Intergovernmental Panel on Climate Change |
| IR | Infrared |
| IWGEO | Interagency Working Group on Earth Observations |

J

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|-----|---------------------------|
| JPL | Jet Propulsion Laboratory |
|-----|---------------------------|

L

| | |
|---------|--|
| LAHARZ | Lahar Zonation (lahar run-out model) |
| LAI | Leaf Area Index |
| LGS | Landsat Ground Station |
| LICOR | small infrared analyser for CO ₂ (brand name) |
| LIDAR | Light Detection and Ranging |
| LP DAAC | Land Processes Distributed Active Archive Center |
| LTAP | Long Term Acquisition Plan |
| LULCC | Land Use and Land Cover Change |

M

| | |
|----------|--|
| MASTER | airborne ASTER sensor |
| ME | Memory Effect |
| MEASURE | Mobile Emissions Assessment System for Urban and Regional Evaluation |
| METEOSAT | Meteorology Satellite |
| MISR | Multi-angle Imaging Spectroradiometer |
| MMS | Multi-mission Modular Spacecraft |
| MOC | Mission Operations Center |
| MODIS | Moderate Resolution Imaging Spectroradiometer |
| MRLC | Multi-Resolution Land Characteristics |
| MSCD | Mirror Scan Correction Data |
| MSS | Multispectral Scanner |
| MTF | Modulation Transfer Function |

N

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| | |
|--------|--|
| NALC | North American Landscape Characterization pathfinder project with land cover |
| NASA | National Aeronautics and Space Administration |
| NCEP | National Centers for Environmental Prediction |
| NDVI | Normalized Difference Vegetation Index |
| NED | National Elevation Dataset |
| NEIC | National Earthquake Information Center |
| NGA | National Geospatial-Intelligence Agency |
| NHD | National Hydrography Dataset |
| NIR | Near Infrared |
| NISN | NASA Integrated Services Network |
| NOAA | National Oceanic and Atmospheric Administration |
| NPOESS | National Polar-orbiting Operational Environmental Satellite System |
| NSF | National Science Foundation |
| NTO | Near-Term Opportunities |
| NVEWS | National Volcano Emergency Warning System |

O

| | |
|---------|---|
| OMI | Ozone Monitoring Instrument |
| OP-FTIR | Open-path Fourier Transform Infrared sensor |
| OSTP | Office of Science and Technology Policy |

P

| | |
|--------|---|
| PAC | Partial Solar Calibrator |
| PAGER | Preliminary Assessment for Global Earthquake Response |
| PALSAR | Phased Array L-band Synthetic Aperture Radar |
| PBO | Plate Boundary Observatory (component of Earthscope) |
| PM | Particulate matter, in sizes less than the number of um stated, e.g., PM2.5 |
| POES | Polar-orbiting Operational Environmental Satellites |

Q

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|----|-------------------|
| QA | Quality Assurance |
|----|-------------------|

R

| | |
|-------|--------------------------------------|
| RADM | Regional Acid Deposition Model |
| RAQMS | Regional Air Quality Modeling System |

S

| | |
|-------|---|
| SAR | Synthetic Aperture Radar |
| SCIGN | Southern California Integrated GPS Network |
| SCS | Scan Correlated Shift |
| SGS | Svalbard Ground Station |
| SLC | Scan Line Corrector |
| SMA | Scan Mirror Assembly |
| SME | Scan Mirror Electronics |
| SMOKE | Sparse Matrix Operator Kernel Emissions Modeling System |

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| | |
|---------|----------------------------------|
| SNR | Signal to Noise Ratio |
| SRR | Solid State Recorder |
| SRTM | Shuttle Radar Topography Mission |
| SURFRAD | Surface radiation budget network |
| SWIR | Short Wave Infrared |

T

| | |
|---------|---|
| TDRS | Tracking Data and Relay Satellites |
| TIMS | Thermal Infrared Multispectral Scanner |
| TM | Thematic Mapper (Landsat instrument) |
| TOA | Top-of-Atmosphere |
| TOMS | Total Ozone Mapping Spectrometer |
| TRMM/PR | Tropical Rainfall Measuring Mission/Precipitation Radar |

U

| | |
|--------|---|
| UAV | Uninhabited Aerial Vehicles |
| UNESCO | United Nations Educational, Scientific, and Cultural Organization |
| USAF | United State Air Force |
| USDA | United States Department of Agriculture |
| USGEO | U.S. Group Earth Observations |
| USGS | United States Geological Survey |

V

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|--------|--|
| VAFTAD | Volcanic Ash Forecast Transport and Dispersion model |
| VIIRS | Visible Infrared Imager/Radiometer Suite |
| VNIR | Visible & Near Infrared |

W

| | |
|-----|-----------------------------------|
| WFF | Wallops Flight Facility |
| WGS | World Geodetic System |
| WMO | World Meteorological Organization |
| WRS | Worldwide Reference System |